

would be widely and closely connected with the people, and they would to all appearance—but who can speak with certainty of the effects of any paper constitution—form a vigorous and effective aristocracy.

DEPOSITS OF THE NILE DELTA

IN a previous communication I referred to the probability that the lower portion of the Delta borings belongs to the Pleistocene and Isthmian deposit which underlies the modern Nile mud, and which has been recognised as an important formation by nearly all geologists who have studied the Nile Valley. I now propose to state shortly some objections to the generalisations of the Report on the Nile borings with reference to the causes assigned for the comparative purity of the waters of the Nile, and the character of its sediment, viz. that the former is due to its flowing through a rainless country, and that the latter is derived from the decay of rocks in this rainless area, and this decay produced not by “chemical agencies,” but by “mechanical forces,” namely, the “unequal expansion” of the constituent minerals under the influence of heat and cold, aided by “the force of the wind.”

It is scarcely necessary to premise that neither the water nor the mud of the Nile can be derived from the rainless district through which the river flows, but from the well-watered regions of interior Africa. The White Nile, which carries scarcely any sediment, is a somewhat constant stream, draining a country of lakes, swamps, and forests. The Blue or Dark Nile and the Atbara drain the mountainous country of Abyssinia, deluged with rain in the wet season, and it is these streams, swollen by violent inundations, that supply the Nile with its sediment, the quantity of fresh material carried into the river below the confluence of the Atbara being very small, as the results of the microscopic study of the sediment sufficiently proves, and I can testify from my own examinations of the Nile mud, that its composition, as stated by Prof. Judd, is essentially the same along the course of the Nile as in the upper layers of the Delta borings, though with some local differences in the fineness of the sand and the proportion of argillaceous matter. Thus both the water of the inundations and the material of the alluvial deposit come from a region of copious rains, and where decay of rocks may be supposed to proceed under the ordinary conditions.

What then is the cause of the freedom of the Nile water from saline matter? Simply its derivation from a country of siliceous and crystalline rocks. If, instead of comparing it with the water of the Thames and other streams draining sedimentary districts, it had been compared with that of the lakes and streams of the Scottish Highlands (by no means rainless districts) this would have been apparent. Dr. Sterry Hunt has described and referred to its true cause a fact of the same kind in the case of the Ottawa and St. Lawrence. The former, rising in a region of crystalline rocks, has little more than one-third of the saline matter in solution that is found in the latter, which drains principally a sedimentary country. The proportions in 10,000 parts are, for the Ottawa, only 0.6116, and for the St. Lawrence, 1.6055.¹

But it may be asked, Why in that case is the Nile mud so deficient in kaolin? The answer is, that the current of the river is sufficiently strong to wash out all the more finely comminuted argillaceous matter and to carry it in its turbid waters to the sea. In connection with this, every voyager on the falling Nile must have observed how the mud-banks are constantly falling as they are undermined by the river, and their material carried down to be redeposited. This work goes on even more energetically in the time of the inundations. Thus any given quantity of sediment on its way from Abyssinia to the

Delta is lixiviated thousands of times, and necessarily deprived of its lighter and finer constituents.

But the quantity of kaolin need not originally have been large. The older gneisses and schists do not kaolinise after the manner of Cornish granites, but, when decomposed so as readily to crumble into sand, they still contain much of their more refracting felspar in a perfect state.

These facts are farther illustrated by the agricultural qualities of the Nile alluvium, as they have been explained by Schweinfurth and others. If the alluvial soil were a stiff clay, it would be practically incapable of cultivation in the circumstances of Egypt. If it were mere quartzose sand, it would be hopelessly barren. It is, in fact, an impalpable sand, highly absorbent of water, crumbling readily when moistened, and containing not merely quartz but particles of various silicates and of apatite and dolomite, which, though unaltered when under water, are gradually dissolved by the carbonic acid present in the cultivated soil, yielding alkalies, phosphates, &c., to the crops. In connection with this, recent microscopic examinations by Dr. Bonney of the old crystalline rocks of Assouan, which are probably similar to those farther north, show that, like those of Canada and Norway, they contain numerous crystals of apatite.

As to the mechanical action of the heat of the sun on crystalline rocks, any one who examines the polished surfaces still retained by monuments which in Upper Egypt have been exposed to this influence for thousands of years, must be convinced that no disintegration of this kind occurs. The only evidence of such actions that I have been able to find is the chipping of little circular disks from the exposed sides of nodules of flint on the surface of the desert. Granitic rocks decay, however, in Egypt, as elsewhere, where they are exposed to moisture from the soil, or where, as at Alexandria, they are subjected to the influence of frequent rains and of saline particles carried from the sea. In this connection I may add that Hague, in a paper in *Science* on the decay of the New York obelisk, shows that it had probably suffered (as, according to Wigner, that in London has also done) from atmospheric action before its removal from Alexandria, and that this decay has been greatly increased by the alternations of moisture and frost to which it is subjected in New York.¹

At Assouan, in a climate at present rainless, or nearly so, I was surprised to find that the surface of the gneiss and crystalline schists was in many places decayed to the depth of several feet, so that it was impossible to obtain fresh specimens except from the railway cuttings. This may be due to the action of water and carbon dioxide oozing through the ground, but is more probably a result of more humid climatal conditions in former ages.

I hope at a future date to pursue these interesting questions farther; but in the meantime I shall be content if it has been shown that Egypt owes the advantage of pure, sweet water to the fact that it drinks of mountain streams which the rainless character of its own climate merely preserves from pollution by the drainage of the Cretaceous and Tertiary beds, and that its rich alluvial soil has not been produced by any mechanical action of an exceptional nature, but by the ordinary atmospheric agencies of denudation.

These conclusions, as well as those stated in my previous letter, respecting the depth of the modern alluvium and its relation to the well-known Pleistocene formation which underlies it, could be confirmed by the testimony of most geologists who have studied the valley of the Nile, and more especially of Lartet, Fraas, and Schweinfurth. I hope that as now stated, however imperfectly, they may suffice to induce the Committee materially to modify its Report, or to postpone its publi-

¹ Logan's 'Geology of Canada,' 1865, p. 565.

² The freezing of water in the pores of rocks is undoubtedly an important cause of destruction in the colder climates.

cation until those members of the Royal Society who have studied the geology of Egypt can have opportunity to discuss it fully.

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NOTES ON THE "MUIR GLACIER" OF ALASKA

IN a recent number of NATURE (vol. xxxii. p. 162) an abstract is made of a San Francisco newspaper account of the "Great Glacier" of Alaska. This account is not very accurate, and as I spent a few hours on this glacier during a flying visit to Alaska in the summer of 1884, I think my observations may be worth recording. I have heard that some descriptions by American observers have already been published, but have not been able to procure them. However, as there are one or two features to which it may be useful to draw the attention of future explorers in this region, I will give my observations just as I made them, and apologise beforehand if they should be found to overlap those of others.

On August 1, 1884, I took passage from Victoria, Vancouver Island, on the steamer—on this occasion the *Ancon*—which carries the monthly mail from ports on Puget Sound to Sitka, Alaska, and eight days later we steamed up the long fiord known as "Glacier Bay," which opens into the Chilcoot Inlet, being then not far from latitude 59° N. and longitude 136° W. of Greenwich.

On either side of us high snow-capped mountains bordered the fiord, and in their recesses we could see glaciers of all sizes. One large mass filled a deep valley on our left, and reached nearly down to the sea, being apparently only separated from it by a ridge of moraine; and everywhere little patches of blue rested in all the *coulées* near the mountain-tops, and showed by their trail of bare striated rocks and long strings of moraine how much further they must recently have extended.

Here and there a small island rose above the waters of the fiord, and, by its bare rounded outline and *moutonnée* surface, gave evidence that it, too, had once been overspread by the ice. The Indians say that one of these islands which is now above a mile distant from the Great Glacier, was embedded in the ice during their recollection, and I was told that early Russian charts of the coast do not show this fiord at all, but make note of a line of ice cliffs near its present entrance; but though the fiord has undoubtedly been at one time filled with ice, I cannot think that the period was so recent as this would indicate.

All round us the waters of the bay were strewn with masses of floating ice of beautiful colour and fantastic outline, but none were large. Right ahead, a gleaming wall of ice rose up out of the water and completely blocked the fiord, extending with a slight outward bulge from shore to shore. This was the "Great Glacier," or the "Muir Glacier," of Alaska.

In the account in NATURE it is stated that the height of the ice-wall is 500 feet, but I think this is an exaggeration. The master of our steamer thought its highest point might reach 450 feet; my own estimate would place it much lower even than this. Where I stood beneath it on the eastern shore I do not think it was more than 240 feet high, judging from the better-known height of an abutting cliff of sand and gravel presently to be described; but as the upper surface of the glacier appeared to be slightly domed, so as to be highest in the centre of the bay and lowest near the mountains, I should say that near the middle of the fiord the cliffs might be nearly 100 feet higher than where I stood; but in my opinion they nowhere exceeded 350 feet.

The breadth of this ice-wall was about three miles. Huge masses were constantly splitting from it and sliding down into the sea with a loud dull roar. As they slid they raised a white dust-like cloud, and when they fell into the water great waves leaped in upon them and dashed high

up the ice cliff, rebounding and causing every now and again a broad deep ground-swell which we could watch as it rapidly swept towards us.

The water through which we passed had changed when we first entered the fiord from the deep dark blue of the outer channel to a beautiful pale green, and now became quite clouded and of a milky greenish-white; and when we came nearer the glacier strong springs were observable, bursting up through the sea-water so as to rise slightly above its level. These were some little distance from the ice-cliff, which must have projected forward under water.

After having failed in an attempt to make fast to a grounded mass of ice—the largest near us—which rose up in pinnacles to the height of our somewhat stunted topmasts, we anchored near the right, or eastern, shore. Our party was then put ashore on a fine beach of washed sand and shingle, about half a mile from the foot of the glacier.

This beach is formed by the action of the waves on a mass of morainic material which is piled up irregularly between the shore and the bare mountain-side, and, where we landed, sloped back almost insensibly into the glacial gravels. But nearer the glacier the moraine had been cut back so as to form a low cliff, which increased in height as it approached the ice.

This cliff exhibited a clear and very interesting section, of which I made a sketch on the spot, shown in Fig. 1.

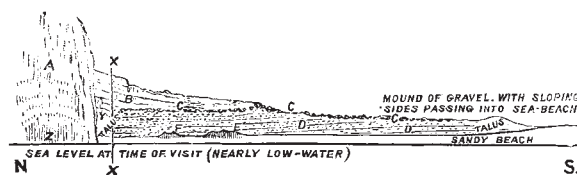


FIG. 1.—Sketch Section of Cliff at the head of Glacier Bay, Alaska, on the eastern shore, adjoining the glacier, Aug. 9, 1884. Length of section about 400 yards; height at X about 100 feet.

A, Eastern end of terminal precipice of Muir Glacier, a nearly vertical wall of very clear blue ice, without stones: the ice shows lines of bedding towards the base, which are strongly curved over a dome-shaped cave (2) from which issues a strong current of muddy water; this cave is filled by the sea at high tide; full height of ice wall, which is about 240 feet here, is not shown.

B, Flange of very stony, dirty ice, apparently descending and flowing forward from the main mass of the glacier at a point some distance behind the line of section: about 60 feet thick at X....X': this passes over the sands and gravels D, and covers them for some distance, but rapidly diminishes in thickness, and seems to fade away into the remainder-bed C.

C, Rubble of angular and water-worn boulders and pebbles mixed with sand and clay; derived from the melting of the stony ice, B, whose lower layers are scarcely distinguishable from this bed.

D, Steep cliff of evenly-bedded sand and gravel; pebbles small and water-worn; shows signs of erosion at junction with C, but the bedding is not disturbed: height at X....X' 40 feet.

E, A small boss of stony, bluish-gray clay resembling till, outcropping below the sands and gravels: full of small water-worn pebbles.

F, Similar boss of fine gray clay without stones: no observable bedding.

NOTES.—In the above figure that part of the section marked A is not on the same plane as the rest, which recedes about 20 yards—the width of the sea-beach.

A narrow gully (g) had been excavated between A and D by water derived from the melting ice, and the lower part of the section was here obscured by talus: c crossed the head of this gully and joined the main mass of the glacier, but it was difficult to study this junction, as the ice of c overhung the gully, and was constantly shedding masses into it.

The size of the patches of clay marked E and F is somewhat exaggerated in the section to make them apparent. I saw only a small surface of each rising above the beach in the cliff-foot; but from the manner of their outcrop I think they may form part of a clayey base on which the gravels rest.

I was not able to give much time to the study of this remarkable section, but was able to satisfy myself on the following points:—That a considerable thickness of *evenly-bedded*, water-worn gravel and sand was in close proximity to an almost vertical wall of ice, if not actually abutting on it. That this bedded gravel and sand was covered for some distance by a mass of dirty ice, full of stones, which was connected in some way with the main mass of the glacier. That the bedding of this deposit